IS 7906-7 (1989): Helical compression springs, Part 7: Quality requirements for cylindrical coil compression springs used mainly as vehicle suspension springs [TED 21: Spring]

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(Reaffirmed 2004)

Indian Standard

HELICAL COMPRESSION SPRINGS

PART 7 QUALITY REQUIREMENTS FOR CYLINDRICAL COIL COMPRESSION SPRINGS USED MAINLY AS VEHICLE SUSPENSION SPRINGS

भारतीय मानक

कुण्डलिनि सपीडन कमानियाँ

भाग 7 मुख्यतः वाहन निलम्बन कमानियों के रूप में प्रयुक्त बेलनकार कुडंलित कमानियों की गुणता सम्बंधी अपेक्षाएँ

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Price Group 3

Springs Sectional Committee, EDC 75

FOREWORD

This Indian Standard (Part 7) was adopted by the Bureau of Indian Standards on 10 February 1989, after the draft finalized by the Springs Sectional Committee had been approved by the Mechanical Engineering Division Council.

Vehicle suspension springs are generally produced, in large-scale manufacture, on largely automatic production lines. The production tolerances thus obtained are generally closer than to that given in IS 7906 (Part 5) : 1989.

They are subjected to statistical relationships which, according to lengthy examination, allow prior calculations to be made. This standard is intended to enable the permissible deviations to be established, of functionally important characteristics in the design of vehicle suspension springs.

This standard is one of a series of standards on helical coiled compression springs. The other standards in the series are as follows:

IS 7906 (Part 1) : 1976	Helical compression springs: Part 1 Design and calculations for springs made from circular section wire and bar
IS 7906 (Part 2) : 1975	Helical compression springs: Part 2 Specification for cold coiled springs made from circular section wire and bar
IS 7906 (Part 3) : 1975	Helical compression springs: Part 3 Data sheet for specifications for springs made from circular section wire and bar
IS 7906 (Part 4) : 1987	Helical compression springs: Part 4 Guide for selection of standard cold coiled springs made from circular section wire and bar
IS 7906 (Part 5) : 1989	Helical compression springs: Part 5 Specification for hot coiled springs made from circular section bar (*first revision*)
IS 7906 (Part 6) : 1978	Helical compression springs: Part 6 Design and calculation for springs made from rectangular section bar steel
IS 7906 (Part 8) : 1989	Helical compression springs: Part 8 Method of inspection of hot coiled compression springs made from circular section bars

In the preparation of this standard considerable assistance has been derived form DIN 2096 Part 2-1979 'Cylindrical coil compression springs made from round rods — Quality requirements for mass production', issued by the Deutsches Institut für Normung (DIN).

Indian Standard

HELICAL COMPRESSION SPRINGS

PART 7 QUALITY REQUIREMENTS FOR CYLINDRICAL COIL COMPRESSION SPRINGS USED MAINLY AS VEHICLE SUSPENSION SPRINGS

1 SCOPE

1.1 This standard (Part 7) lays down permissible deviation of spring parameters of hot coiled cylindrical compression springs made from round bar steel and produced on large scale.

1.2 This standard is applicable to springs meeting with the following conditions:

a) Large-scale production, minimum lot size 5 000 pieces.

b) Bar length (l) up to 4 300 mm.

c) Bar diameter (d) from 9 to 18 mm.

d) Length of unloaded spring (free length) (L_o) up to 600 mm

e) External coil diameter (D_e) up to 180 mm.

f) Number of active coils (n) from 5 to 12.

g) Total spring deflection (s_c) 180 mm and more.

h) Spring index (W) from 6 to 12.

2 TERMINOLOGY

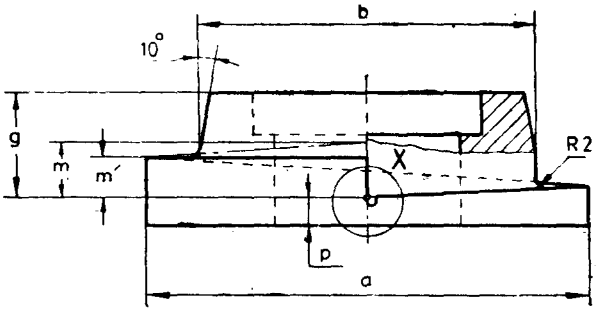
The following symbols and units shall apply:

Symbol	*Designation*	*Unit*
A_D	Permissible deviation of coil diameter	mm
A_F	Permissible deviation of the spring force F at specified spring length L	N
A_R	Permissible deviation of the spring rate R	N/mm
A_{nt}	Permissible deviation of the total number nt of coils	—
$D=\frac{D_e+D_i}{2}$	Mean coil diameter	mm
D_e	External coil diameter	mm
D_i	Internal coil diameter	mm
F	Spring force	N
$F_{e\ theo}$	Theoretical spring force associated with solid length L_c	N
F_{pruf}	Spring force at test length L_{pruf}	N
F_1, F_2	Spring forces at spring lengths L_1, L_2	N
L	Spring length	mm
L_a	Length of bending surface	mm
L_c	Solid length, shortest possible spring length (all coils in contact)	mm
L_{pruf}	Test length	mm
L_o	Length of the unloaded spring (free length)	mm
L_1, L_2	Lengths of spring under forces F_1, F_2	mm
Q	Quality grade coefficient	—
R	Spring rate	N/mm
b	Deviation of spring form from the cylindrical form	mm
d	Diameter of bar	mm
d_o	Diameter of bar at ends of spring	mm
k_R	Factor used in determination of the permissible deviation of the spring rate R	—
l	Length of bar	mm
n	Number of active coils	—
n_t	Total number of coils	—
s	Spring deflection	mm
s_c	Total spring deflection to solid length L_c	mm
$\omega=\frac{D}{d}$	Spring index	—

3 TESTING AND PERMISSIBLE DEVIATION OF SPRING FORCE AND SPRING RATE

3.1 Test Arrangement

For test purposes, the springs are held in seating fixtures. In the case of springs having ends closed and formed flat plane parallel seating fixtures are used, having a centralizing feature for the internal diameter of the end coils. Springs whose end coils terminate with the full thickness of the wire are held in seatings with helical abutment surfaces, which centralize the end coils on the internal diameter and support them over an angle of 270° (*see* Fig. 1 and Fig. 2).



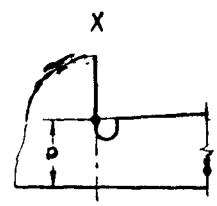


FIG. 1 SEATING FIXTURE FOR COIL COMPRESSION SPRINGS HAVING ENDS WITHOUT TANGS*

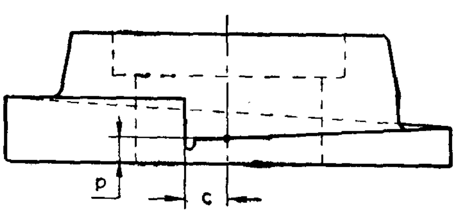


FIG. 2 SEATING FIXTURE FOR COIL COMPRESSION SPRINGS HAVING ENDS WITH TANGS*

The pitch m' of the seating fixture should correspond to the diameter of the bar from which the end coils are wound.

For angle 270° : $m' = 0.75 \times d_o$

Before the spring force and spring rate are checked, the springs are to be compressed to solid length L_c, at least once.

3.2 Spring Force

The spring force must be checked in the range of the spring deflection of:

$0.3 \times s_c$ to $0.7 \times s_c$

Permissible deviation of the spring force :

$$AF_{prut} = + (0.01 \times F_{c\ theo} + Q_x\ F_{prut}) \quad ...(1)$$

For coefficient Q:

Quality grade A : $Q = 0.01$

Quality grade B : $Q = 0.02$

The quality grade A requires greater effort in order to keep within the narrower tolerances.

The tolerance zone of a quality grade can further be sub-divided into test groups. The quantitative distribution of spring among these test groups is obtained from the statistical distribution together with the standard deviation belonging to the particular production lot.

The tolerance zone of each test group (group width) should be $\geqslant 0.02\ F_{prut}$, and should be at least 60 N.

In consideration of deviations which are possible in the cross-checking of spring forces, the limits of tolerance may be exceeded by $0.01\ F_{prut}$, including those of the individual test groups.

As an alternative to the sorting of springs into test groups, they may be grouped in pairs. The maximum force difference between the springs of a pair is then $\leqslant 0.5\ A_F$.

3.3 Scragging

Each and every spring shall be scragged three times in quick succession. The scragging height should be as indicated in the spring drawing/data sheet. In case, there is no such indication, the spring shall be scragged home. The scragging load in each case should not exceed 1.5 times the theoretical axial load corresponding to the block length.

a	b	c	g	m	m'	p
$D_e - 2$	$D_e - 2d_o - 3$	Length of tang	$2 \times d_o$	d_o	$0.75 \times d_o$	$< 0.5 \times d_o$

*Tang is the term applied to the straight run-out ends of the bar.

3.4 Spring Rate

3.4.1 *Spring Rate with Linear Characteristics*

The spring rate shall be tested in the range of spring deflection from $0{\cdot}3\, s_c$ to $0.7 s_c$.

The spring rate R is defined as the differential quotient:

$$R = \frac{\Delta F}{\Delta s} \qquad \text{...(2)}$$

The difference in spring deflection Δs used in testing should be 50 mm.

Permissible deviation of the spring rate:

$$A_R = \pm k_R \times R \qquad \text{...(3)}$$

The factor k_R is essentially a function of the number of effective turns and may be taken from the accompanying graph (*see* Fig. 3) or calculated from the expression:

$$k_R = 0{\cdot}047\ 14\ \frac{n}{100} \qquad \text{...(4)}$$

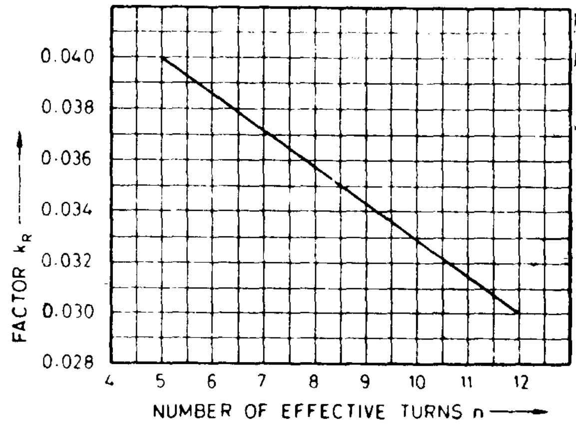


FIG. 3 FACTOR k_R AS A FUNCTION OF THE NUMBER OF EFFECTIVE TURNS

3.4.2 *Spring Rate with Progressive Characteristics*

In the case of coil compression springs with progressive characteristics, testing and determination of the permissible deviations are not possible in the same way as for springs with linear characteristics, since the determination of only one differential quotient $\frac{\Delta F}{\Delta s}$ does not describe the form of the rate characteristics. Testing is, therefore, generally carried out in accordance with the following scheme (*see* Fig. 4).

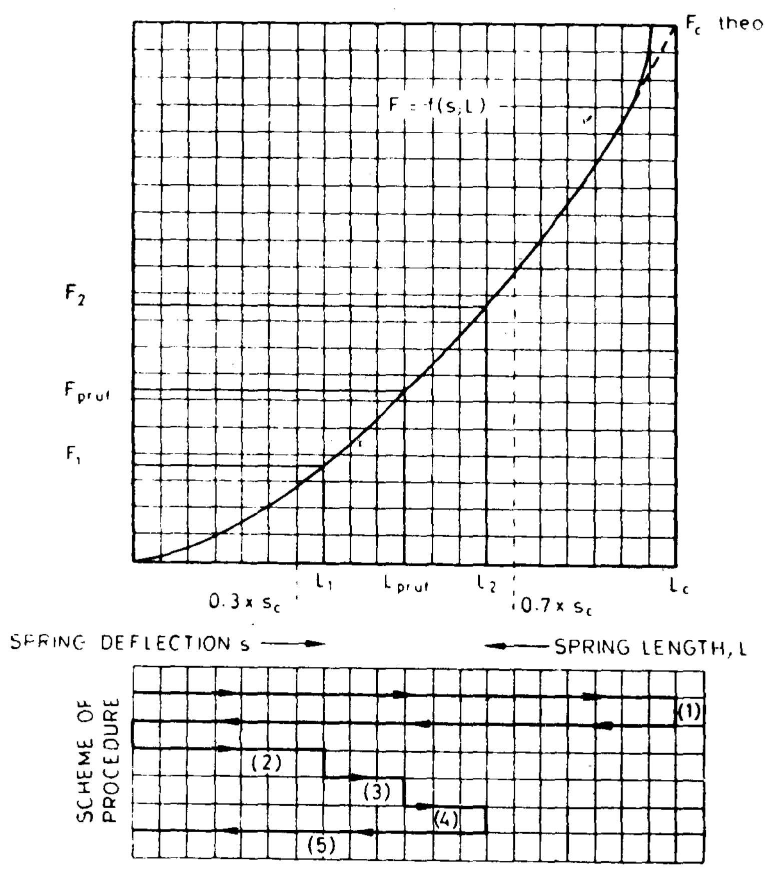


FIG. 4 DIAGRAM OF PROCEDURE FOR INSPECTION TESTING OF COMPRESSION SPRINGS WITH PROGRESSIVE RATE CHARACTERISTICS

where:

1) Compress spring to solid length L_c and unload
2) Compress spring to length L_1 and read off associated spring force F_1
3) Compress spring to length L_{pruf} and read off associated spring force F_{pruf}
4) Compress spring to length L_2 and read off associated spring force F_2
5) Unload spring

The spring lengths must lie in the range of spring deflection

$$0{\cdot}3 \times s_c \text{ to } 0{\cdot}7 \times s_c$$

The permissible deviation AF_{pruf} of the spring force F_{pruf} is calculated from equation (1) with coefficient Q from **3.2**.

Permissible deviations of the spring forces F_1 and F_2:

$$A_{F\,1,\,2} = \pm 1{\cdot}3\ (\,0{\cdot}01\ F_{c\ theo} + QF_{1,\,2}\,) \quad \ldots(5)$$

4 BAR DIAMETER

For vehicle suspension springs, only bars with the machine-finished surface are employed. Because of the stringent requirement for accuracy of the spring rate, the bar diameter is not toleranced. The spring manufacturer is thereby afforded the opportunity to make a manufacturing adjustment.

5 TESTING AND PERMISSIBLE DEVIATION OF THE END-TURN DIAMETER

According to the method of assembly adopted in a particular application (spring ends centralised from the internal or external diameter), either the internal coil diameter D_i on the external coil diameter D_e is toleranced. The permissible deviations of the end coil diameter are:

$$A_{De} = \pm 0{\cdot}012\ D_e \quad \ldots(6)$$

If the internal turn diameter D_i is toleranced, the external turn diameter D_e is still measured, in the same way (*see* Fig. 5 with **2**):

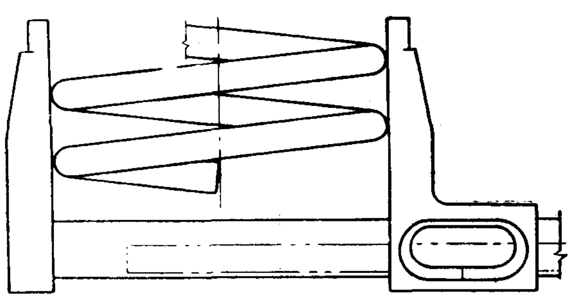


FIG. 5 EXAMPLE OF MEASUREMENT OF THE EXTERNAL DIAMETER OF THE END TURN

D_i is then given by the equation

$$D_i = D_e - 2d_o \quad \ldots(7)$$

6 PERMISSIBLE TOTAL NUMBER OF TURNS

The permissible deviation of the total number of turns is:

$$A_{nt} = \pm 0{\cdot}012 \times n_t \quad \ldots(8)$$

The corresponding permissible deviation in mm is:

$$A_{nt} \times D\pi$$

The corresponding permissible deviation in degree is:

$$A_{nt} \times 360$$

In special cases, for example with springs whose end turns terminate with the bar at its full thickness, and which are not held in rotatable spring seating fixtures, a special quality with reduced tolerance can be agreed:

$$A_{nt} = \pm 0{\cdot}005 \times n_t \quad \ldots(9)$$

7 DEVIATIONS OF FORM

Unlike the practice in IS 7906 (Part 5) : 1989 tolerancing of the quantities e_1 and e_2 is dispensed with, for vehicle suspension springs. Instead of this, a check can be agreed on the deviation b from cylindrical form on the unloaded spring. This deviation of form is tested as shown in Fig. 6 by insertion of the spring into a checking sleeve.

Permissible deviation of the cylindrical form is:

$$b = 0{\cdot}015 \times L_o$$

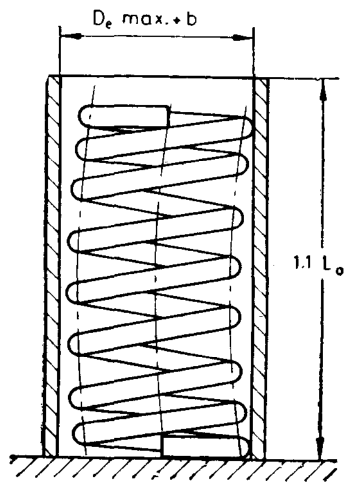


FIG. 6 CHECKING OF THE FORM DEVIATION

The deviation from the cylindrical form varies in amount and position with loading of the spring. This depends not only on the geometrical properties of the spring (slenderness ratio, spring index, number of turns, pitch of turns) but also on the conditions of production, and is not susceptible to accurate determination in advance. Whenever any detriment to the functioning of the spring is to be expected from this

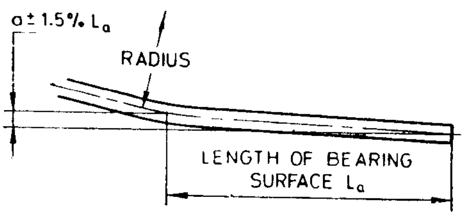
cause; agreement should be reached between the spring manufacturer and user, concerning the critical envelopes surface range and loading range.

8 TOLERANCE ON DEVELOPED PROFILE OF END COILS OF SPRINGS

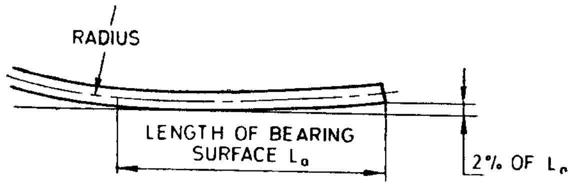
Coils having open end with a pitch different from active coils shall have the following tolerance:

a) Tolerance on the inclination *a* of the end coils

   Tolerance on *a* = 1·5 percent of bearing length of the last coil.



b) Tolerance of planarity of the end coil. Deformation of 2 percent is permitted on the length of the bearing surface.



9 FATIGUE TEST

Fatigue test shall be carried out as per agreement between the supplier and the purchaser. Where no value is specified it is recommended that load/length relaxation after 350 000 cycles shall not exceed 3 percent.

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